Supplementary Material for

Economics of Informed Antibiotic Management and Judicious Use Policies in Animal Agriculture

Figures

To illustrate how farmer's disease management decisions are determined by key parameters in our model (i.e., self-test cost, veterinary service cost, and antibiotic cost), we graph the optimal strategies each time, holding one cost parameter among (b, d, v) fixed. C1-C3 summarize the optimal strategies in the b-d, b-v and d-v planes correspondingly. C4 summarizes comparisons between unregulated private strategies and social optimum. C5-C7 summarize the optimal strategies under PR in the b-d, b-v and d-v planes correspondingly. Within each section, we investigate how optimal strategy outcomes vary with cost parameters. To assess the impact of PR on the farmer's optimal strategies, we compare the privately optimal strategies without and with PR in C8-C10 in the b-d, b-v and d-v planes correspondingly and compare the privately optimal strategies under PR with social optimum in C11.

C1 Farmer's optimal strategies without PR in the b-d plane

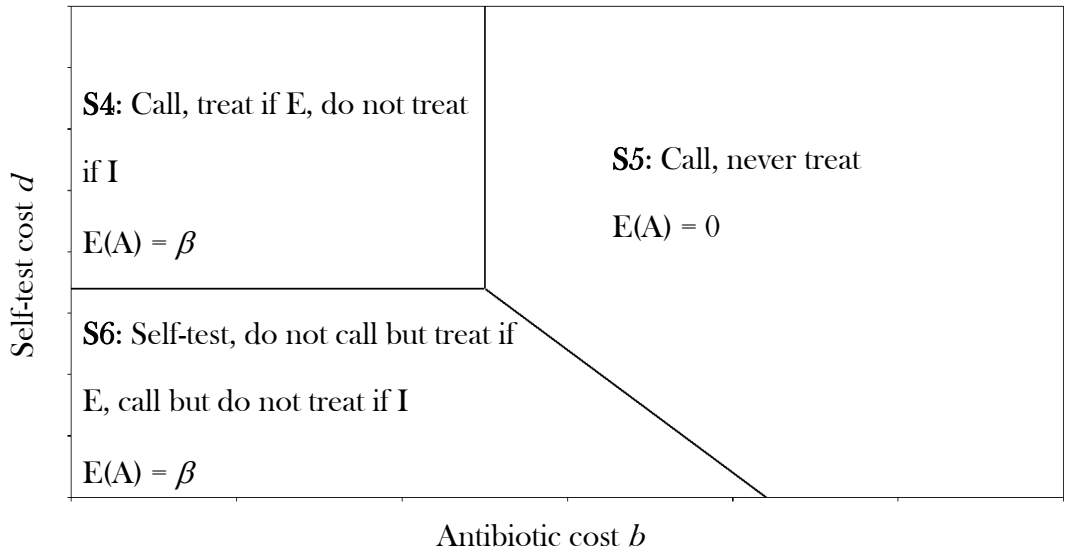

Figure C-1 Farmer's optimal strategies in the b-d plane given low veterinary service cost $v < (1-\beta)(l_3 - l_2)$.

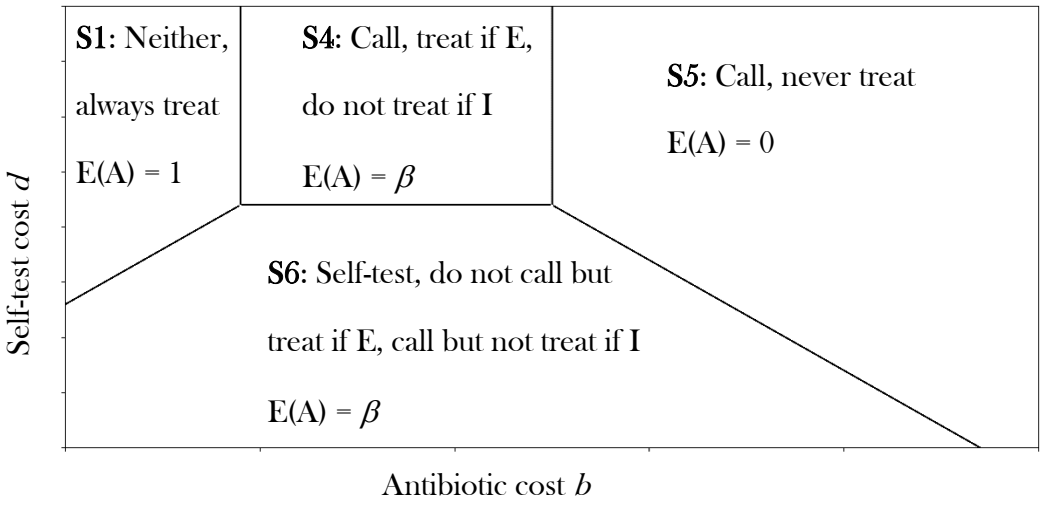

Figure C-2 Farmer's optimal strategies in the b-d plane given lower medium veterinary service cost $(1-\beta)(l_3-l_2) < v < (1-\beta)(l_3-l_1)$.

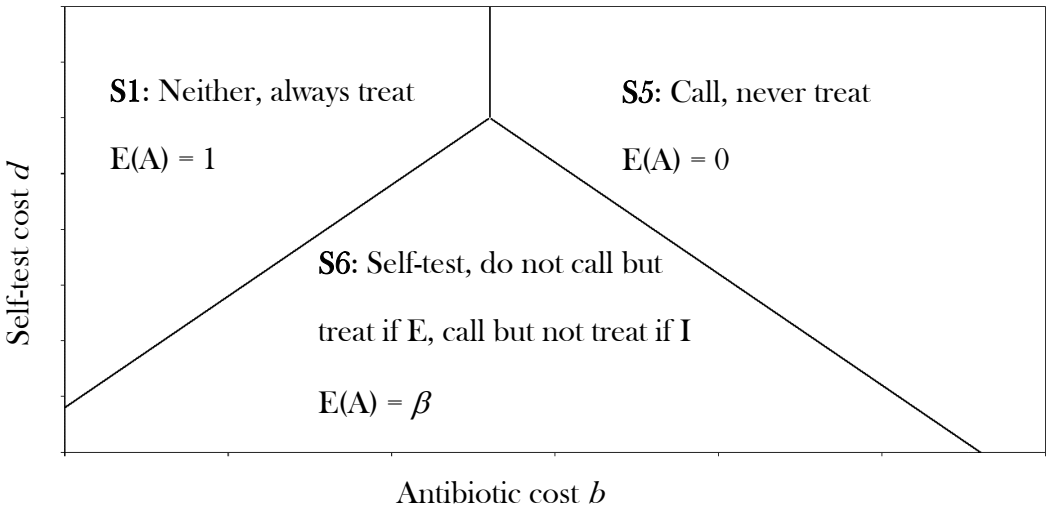

Figure C-3 Farmer's optimal strategies in the b-d plane given upper medium veterinary service cost $(1-\beta)(l_3-l_1) < v < l_3-l_2$.

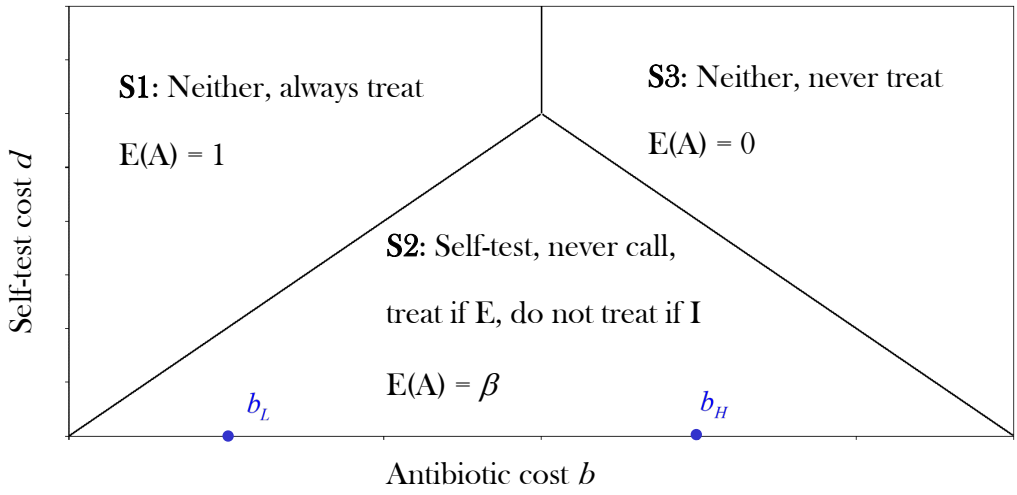

Figure C-4 Farmer's optimal strategies in the b-d plane given high veterinary service cost $v > l_3 - l_2$.

C2 Farmer's optimal strategies without PR in the b-v plane

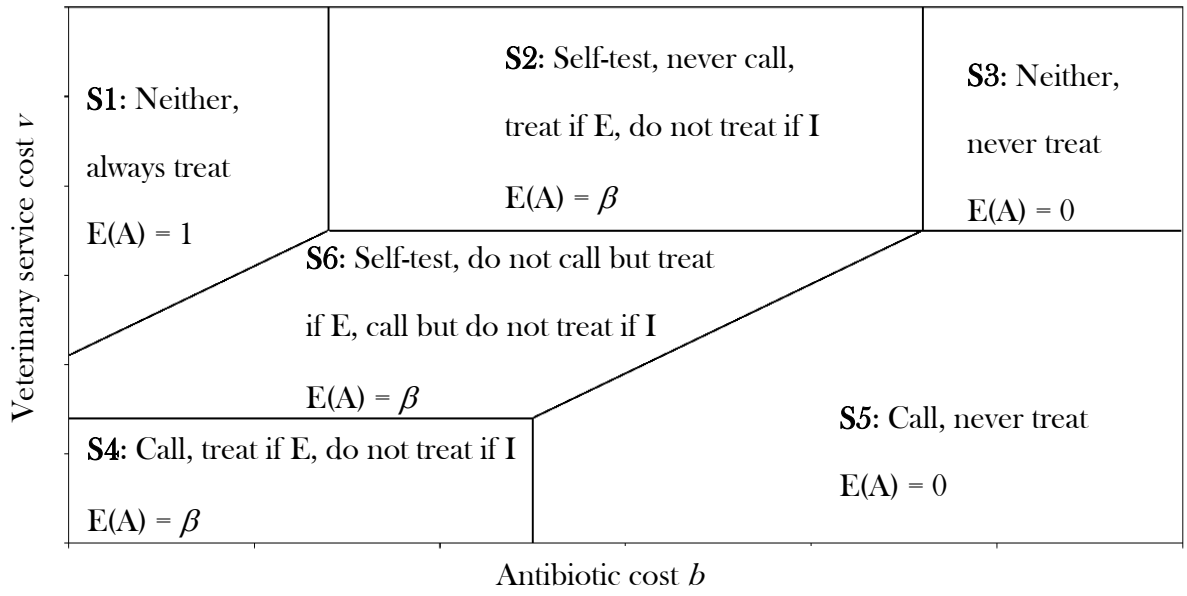

Figure C-5 Farmer's optimal strategies in the b-v plane given low self-test cost $d < \beta(1-\beta)(l_3 - l_1)$.

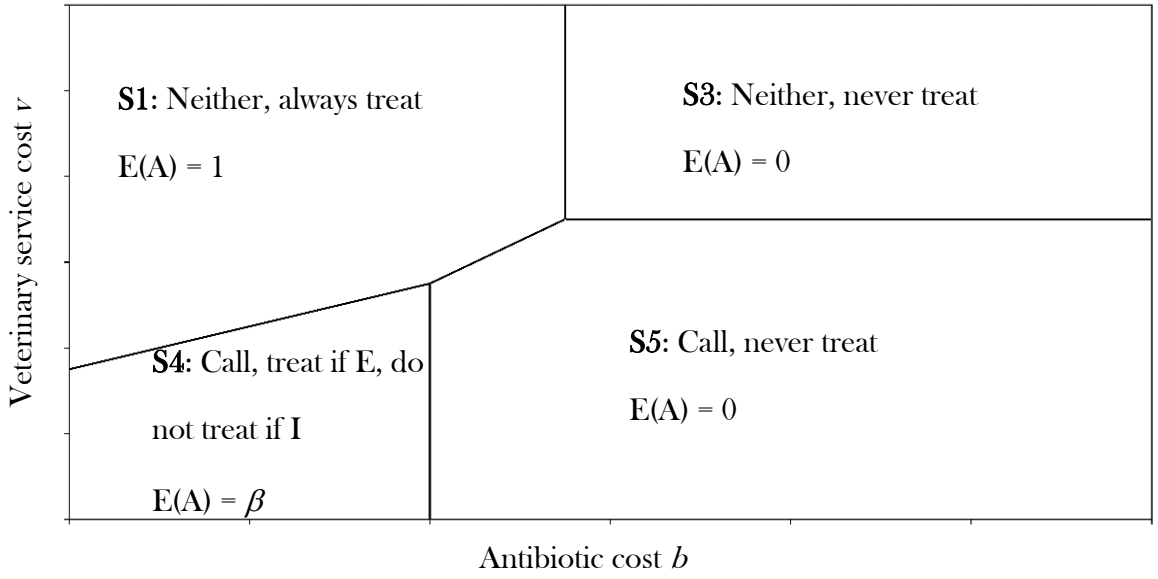

Figure C-6 Farmer's optimal strategies in the b-v plane given high self-test cost $d > \beta(1-\beta)(l_3 - l_1)$.

C3 Farmer's optimal strategies without PR in the d-v plane

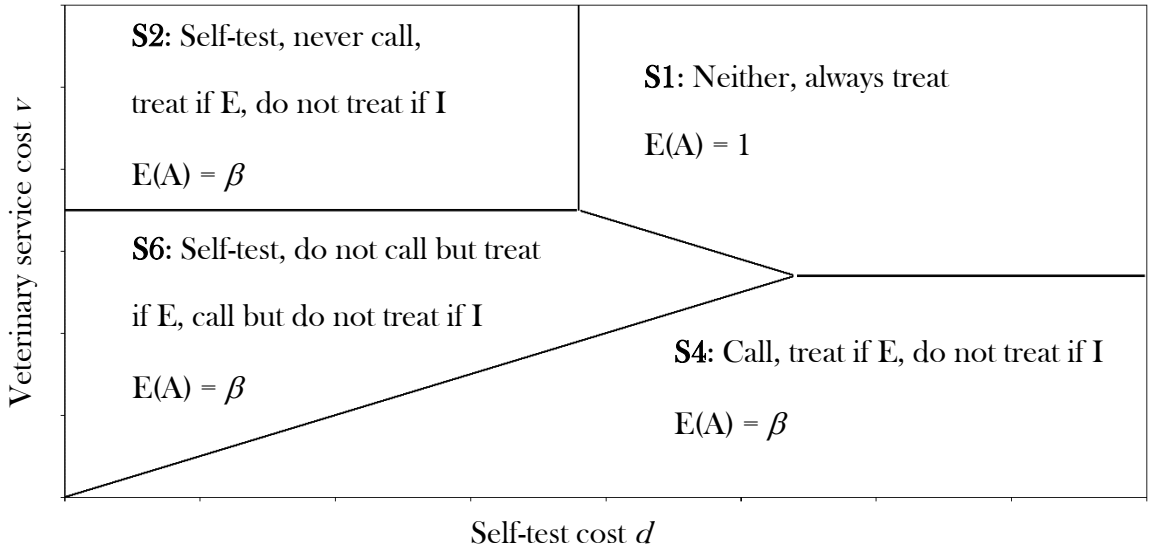

Figure C-7 Farmer's optimal strategies in the d-v plane given low antibiotic cost $b < l_2 - l_1$.

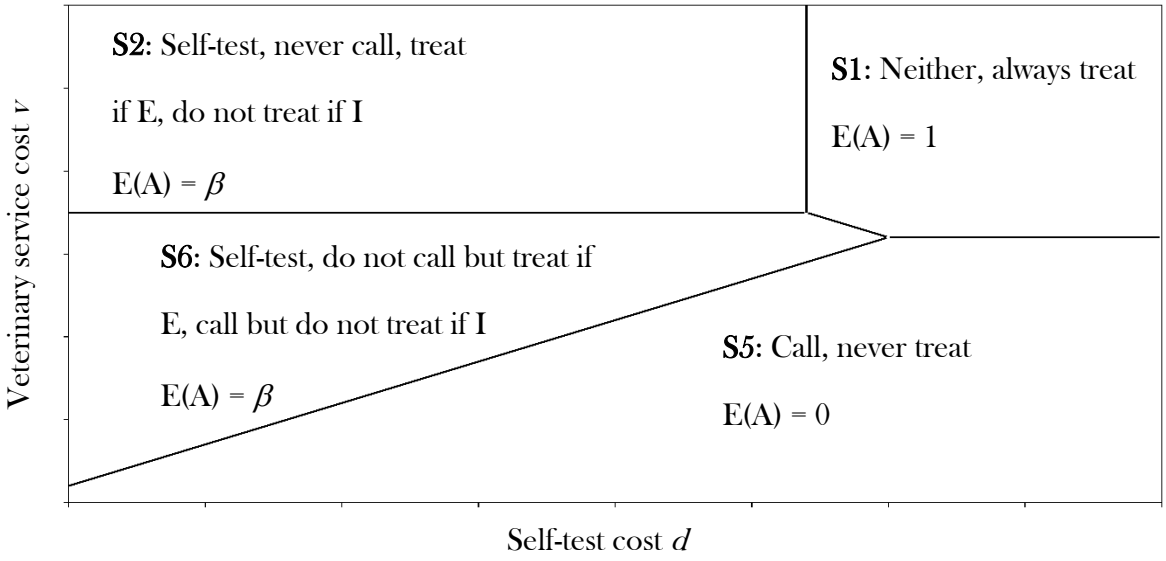

Figure C-8 Farmer's optimal strategies in the d-v plane given lower medium antibiotic cost $l_2 - l_1 < b < \beta(l_3 - l_1)$.

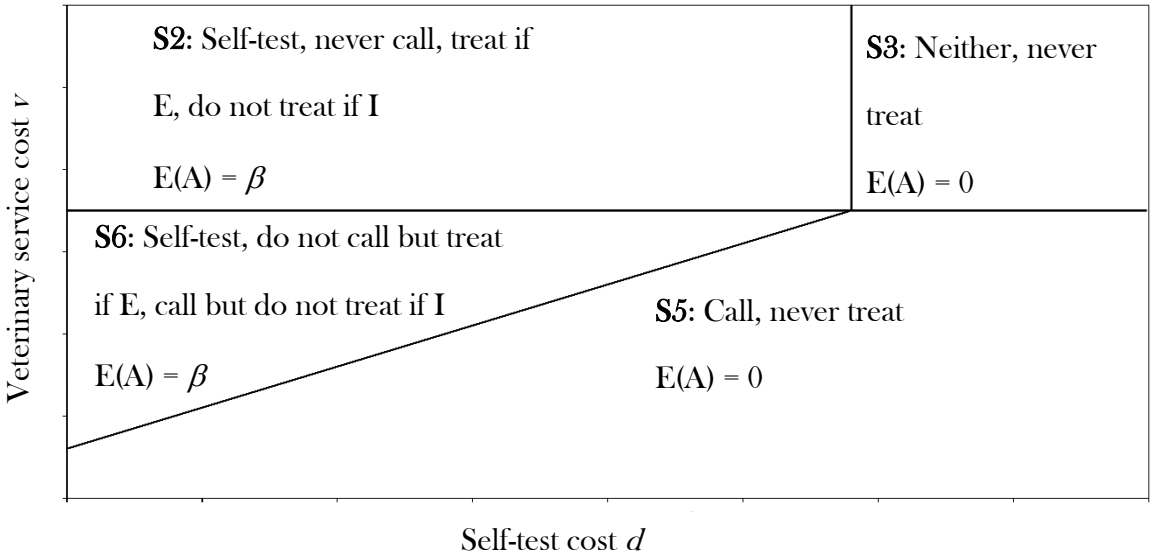

Figure C-9 Farmer's optimal strategies in the d-v plane given upper medium antibiotic cost $\beta(l_3 - l_1) < b < l_3 - l_1$.

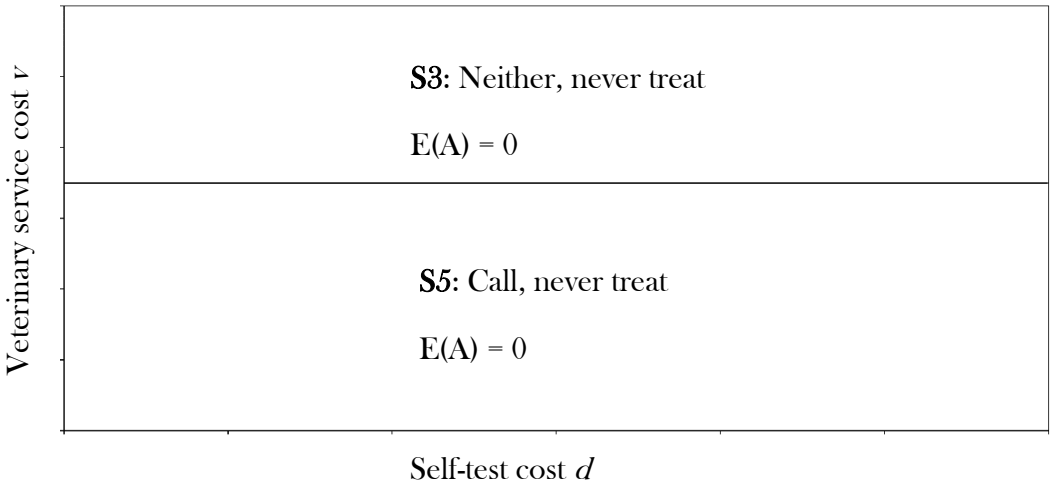

Figure C-10 Farmer's optimal strategies in the *d*-*v* plane given high antibiotic cost.

C4 Compare privately optimal decisions with socially optimal decisions

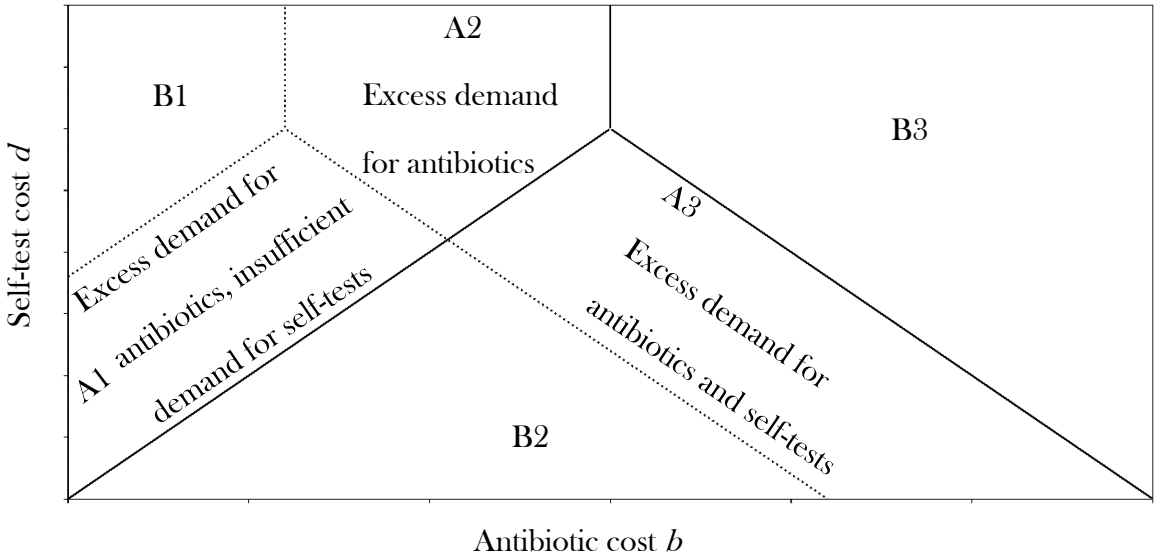

Figure C-11 Comparison between farmer's optimal strategies and social optimum in the b-d plane given high veterinary service cost $v > l_3 - l_2$

Area	Farmer's optimal strategies	Social optimum
A1	**S1**: Neither call nor self-test, always treat	**S2**: Self-test, never call, treat if E, do not treat if I
A2	**S1**: Neither call nor self-test, always treat	**S3**: Neither call nor self-test, never treat
A3	**S2**: Self-test, never call, treat if E, do not treat if I	**S3**: Neither call nor self-test, never treat
B1	**S1**: Neither call nor self-test, always treat	Same
B2	**S2**: Self-test, never call, treat if E, do not treat if I	Same
B3	**S3**: Neither call nor self-test, never treat	Same

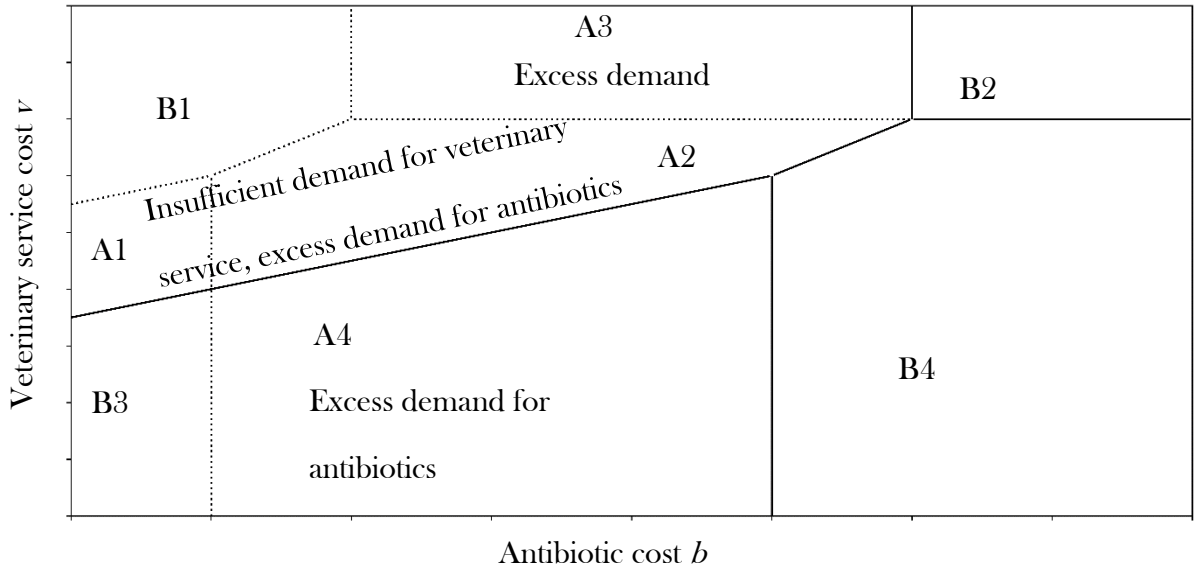

Figure C-12 Comparison between farmer's optimal strategies and social optimum in the *b*-*v* plane given high self-test cost $d > \beta(1-\beta)(l_3 - l_1)$

Area	Farmer's optimal strategies	Social optimum.
A1	**S1**: Neither call nor self-test, always treat	**S4**: Call, treat if *E*, do not treat if *I*
A2	**S1**: Neither call nor self-test, always treat	**S5**: Call, never treat
A3	**S1**: Neither call nor self-test, always treat	**S3**: Neither call nor self-test, never treat
A4	**S4**: Call, treat if *E*, do not treat if *I*	**S5**: Call, never treat
B1	**S1**: Neither call nor self-test, always treat	Same
B2	**S3**: Neither call nor self-test, never treat	Same
B3	**S4**: Call, treat if *E*, do not treat if *I*	Same
B4	**S5**: Call, never treat	Same

C5 Farmer's optimal strategies under PR in the b-d plane

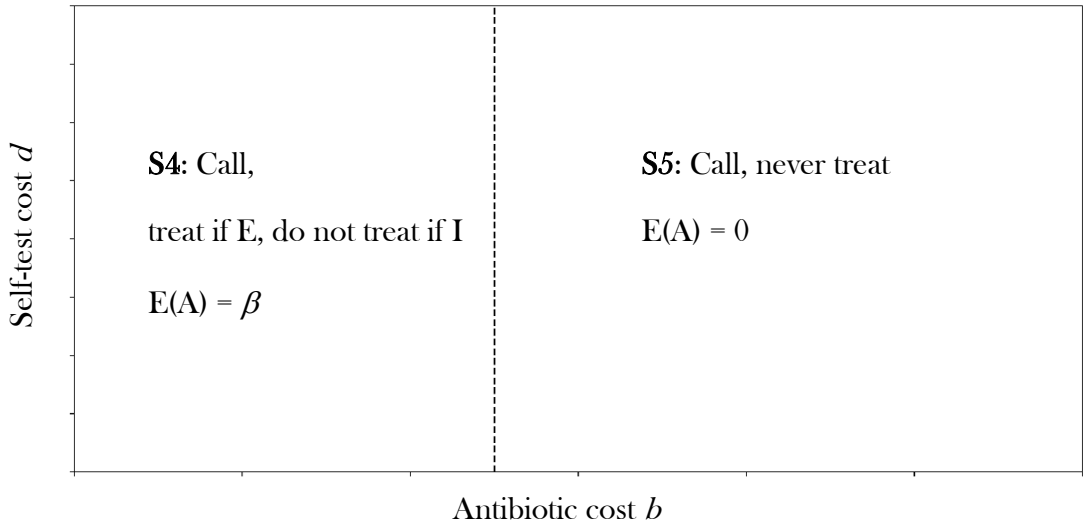

Figure C-13 Farmer's optimal strategies under PR in the b-d plane given low veterinary service cost $v < l_3 - l_2$.

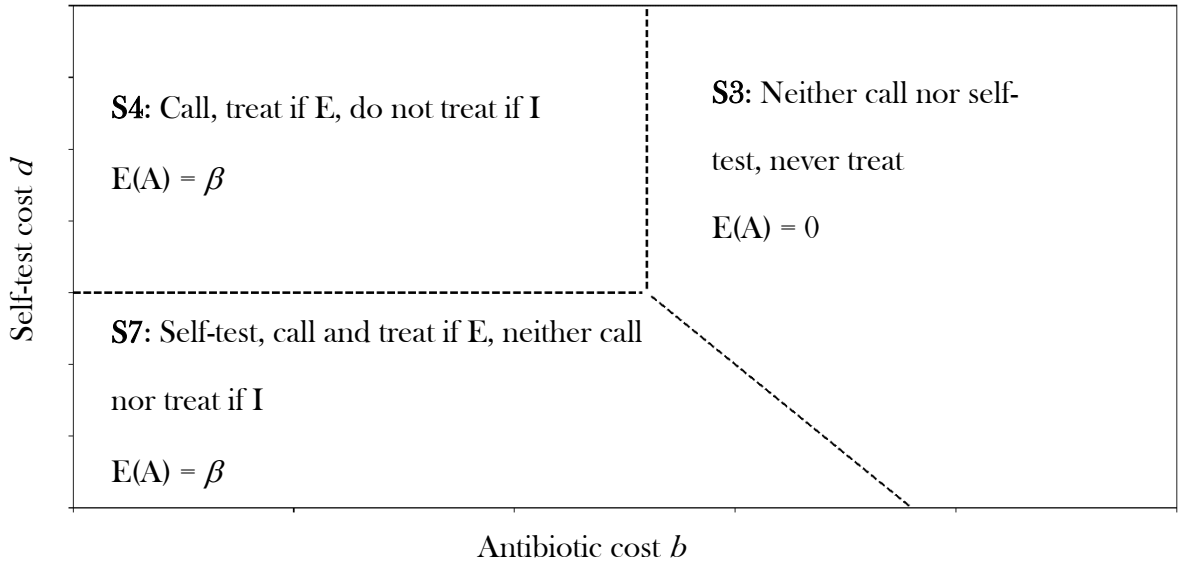

Figure C-14 Farmer's optimal strategies under PR in the b-d plane given lower medium veterinary service cost $l_3 - l_2 < v < l_3 - \beta l_1 - (1-\beta) l_2$.

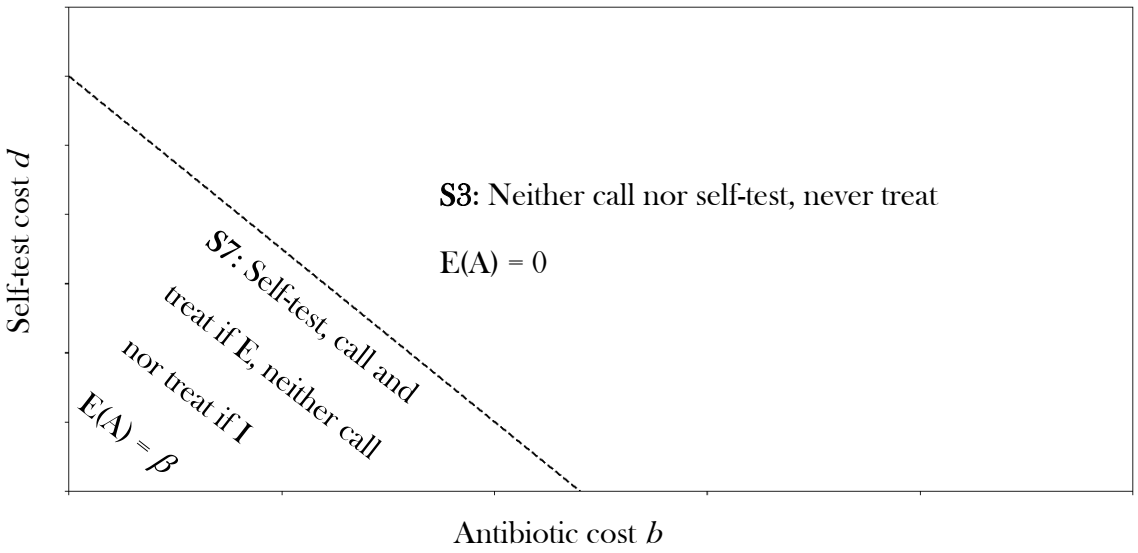

Figure C-15 Farmer's optimal strategies under PR in the b-d plane given upper medium veterinary service cost $l_3 - \beta l_1 - (1-\beta) l_2 < v < l_3 - l_1$.

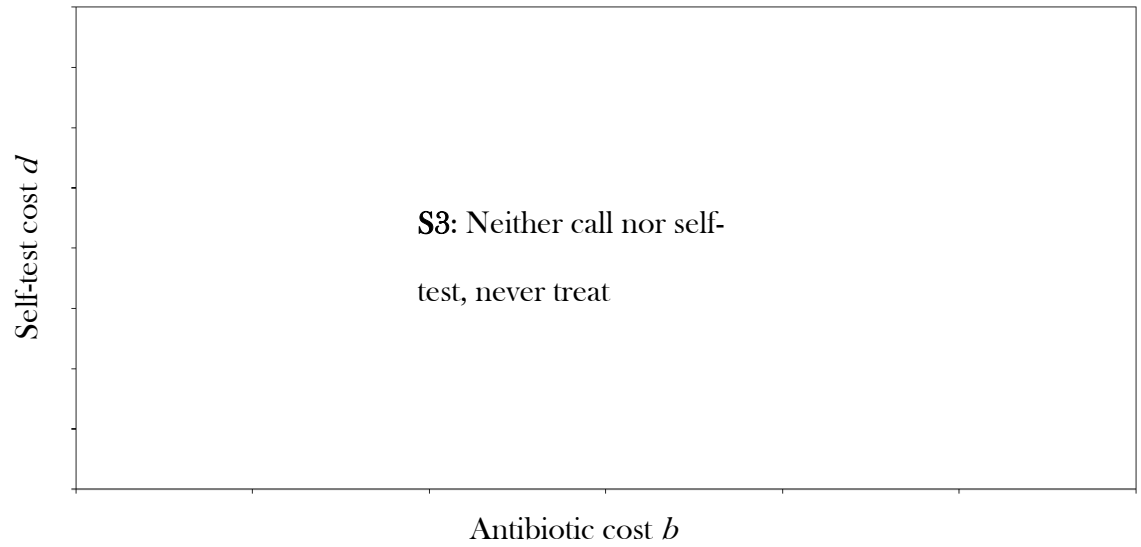

Figure C-16 Farmer's optimal strategies under PR in the b-d plane given high veterinary service cost $v > l_3 - l_1$.

C6 Farmer's optimal strategies under PR in the *b*-*v* plane

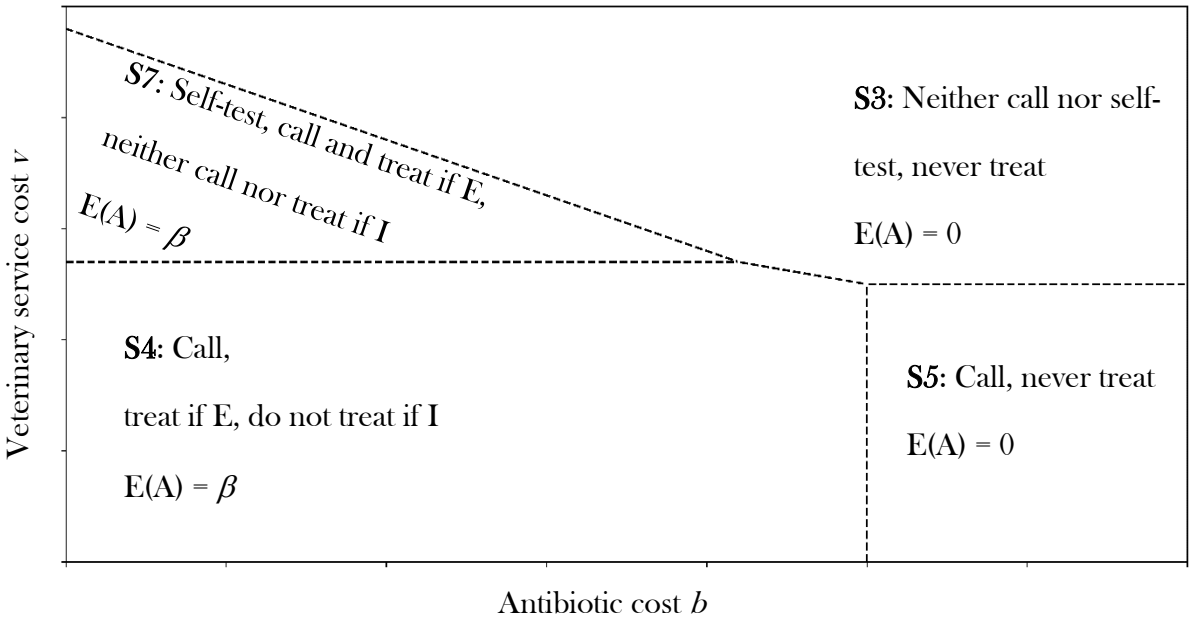

Figure C-17 Farmer's optimal strategies under PR in the *b*-*v* plane given low self-test cost $d < \beta(1-\beta)(l_2 - l_1)$.

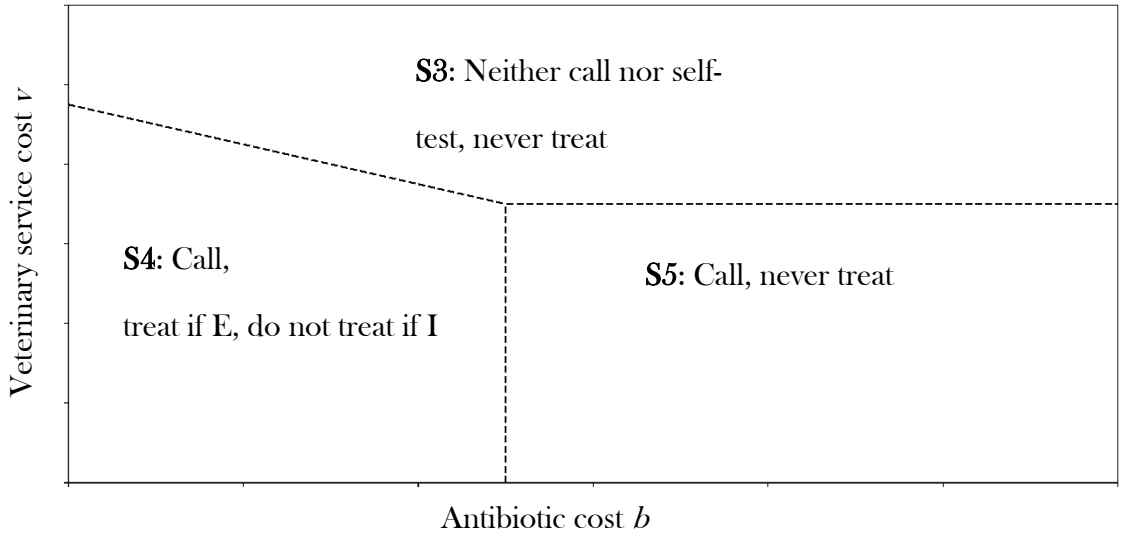

Figure C-18 Farmer's optimal strategies under PR in the *b*-*v* plane given high self-test cost $d > \beta(1-\beta)(l_2 - l_1)$.

C7 Farmer's optimal strategies under PR in the d-v plane

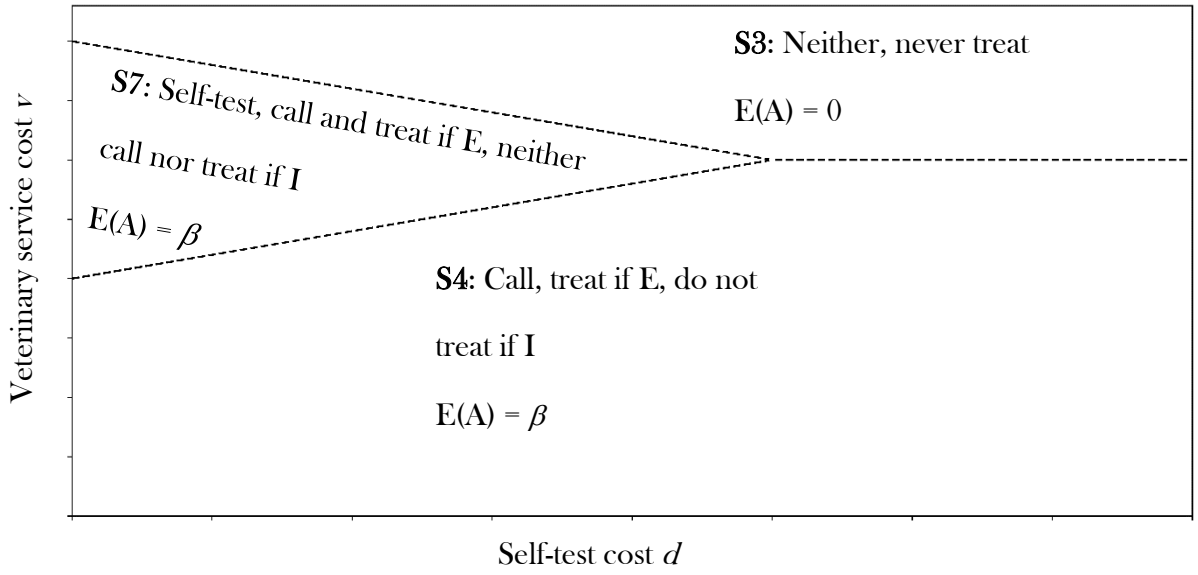

Figure C-19 Farmer's optimal strategies under PR in the d-v plane given low antibiotic cost such that $b < l_2 - l_1$.

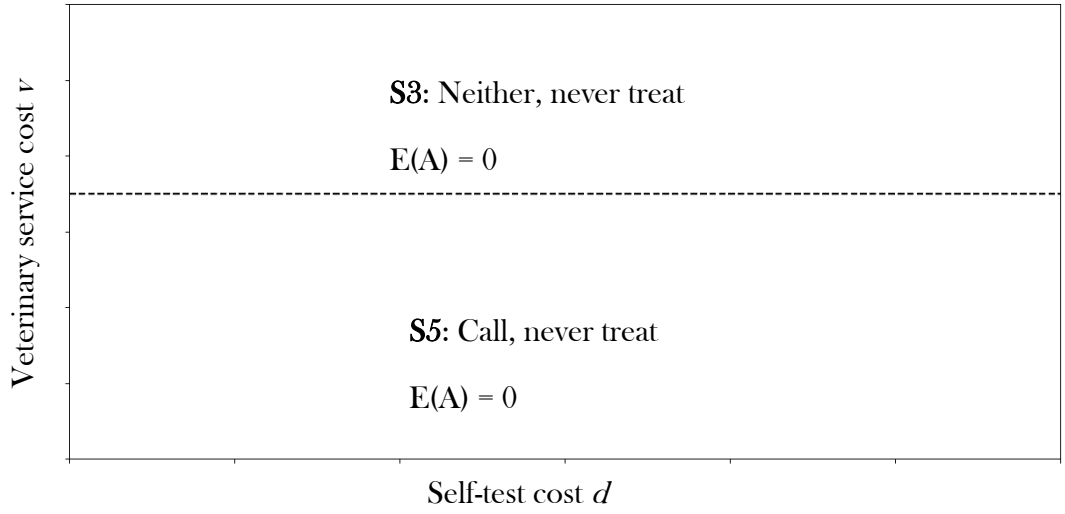

Figure C-20 Farmer's optimal strategies under PR in the d-v plane given high antibiotic cost $b > l_2 - l_1$.

C8 Compare farmer's optimal strategies without and with PR in the *b*-*d* plane

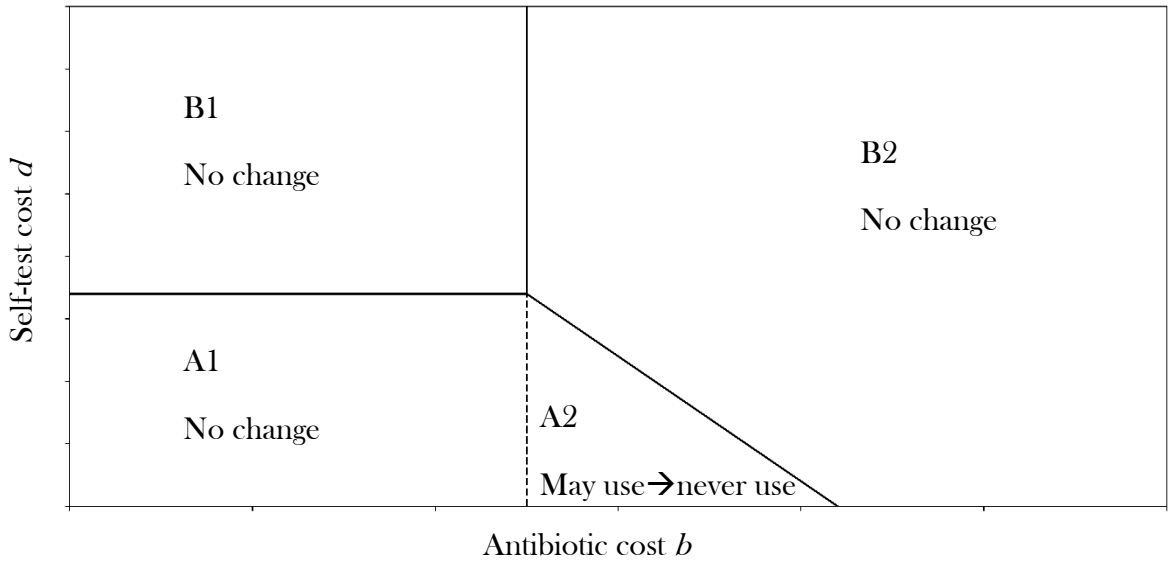

Figure C-21 Comparison between farmer's optimal strategies with and without PR in the *b*-*d* plane when veterinary service cost satisfies $v < (1-\beta)(l_3 - l_2)$.

	Without PR	**Under** PR
A1	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, treat if *E*, do not treat if *I*
A2	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, never treat
B1	Call, treat if *E*, do not treat if *I*	Same
B2	Call, never treat	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

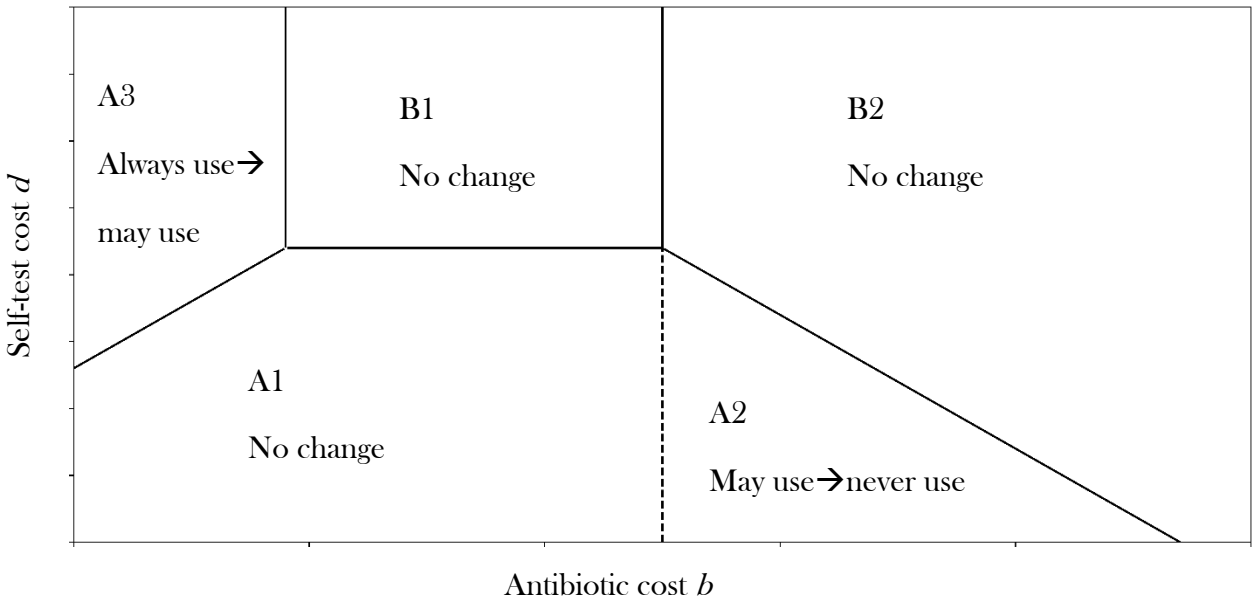

Figure C-22 Comparison between farmer's optimal strategies with and without PR in the *b*-*d* plane when veterinary service cost satisfies $(1-\beta)(l_3-l_2) < v < (1-\beta)(l_3-l_1)$.

	Without PR	**Under PR**
A1	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, treat if *E*, do not treat if *I*
A2	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, never treat
A3	Neither, always treat	Call, treat if *E*, do not treat if *I*
B1	Call, treat if *E*, do not treat if *I*	Same
B2	Call, never treat	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

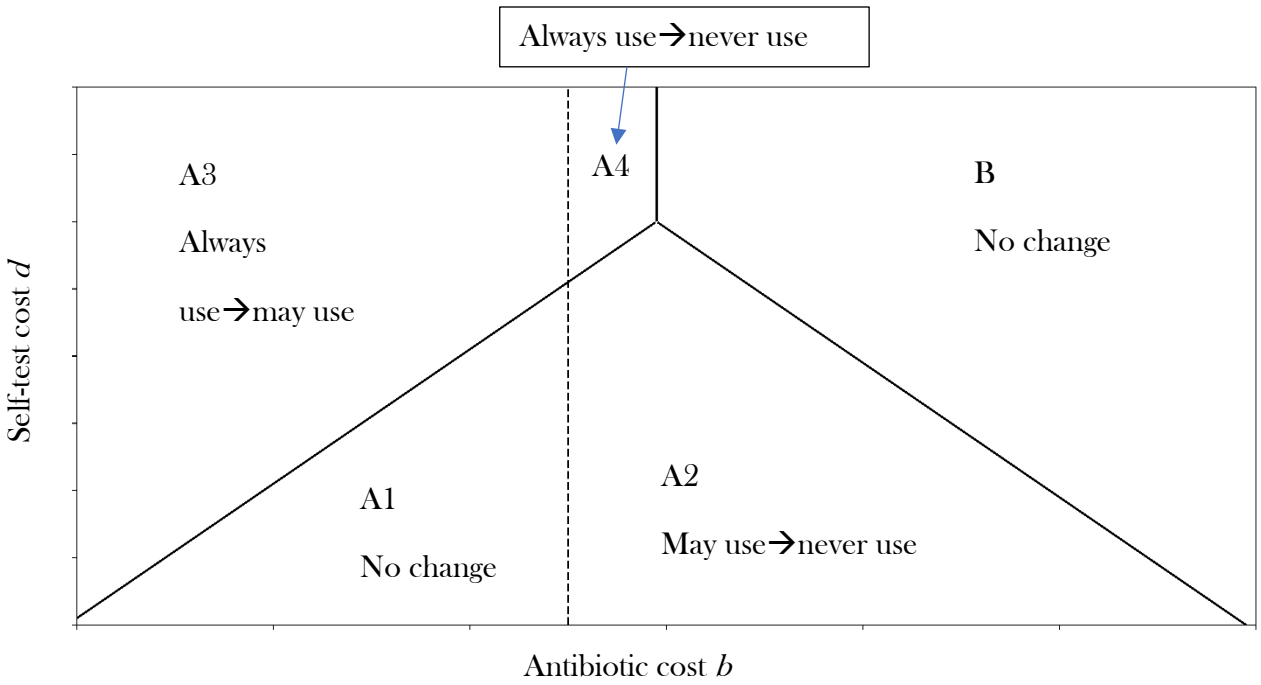

Figure C-23 Comparison between farmer's optimal strategies with and without PR in the *b*-*d* plane when veterinary service cost satisfies $(1-\beta)(l_3-l_1)<v<l_3-l_2$.

	Without PR	**Under PR**
A1	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, treat if *E*, do not treat if *I*
A2	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, never treat
A3	Neither, always treat	Call, treat if *E*, do not treat if *I*
A4	Neither, always treat	Call, never treat
B	Call, never treat	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

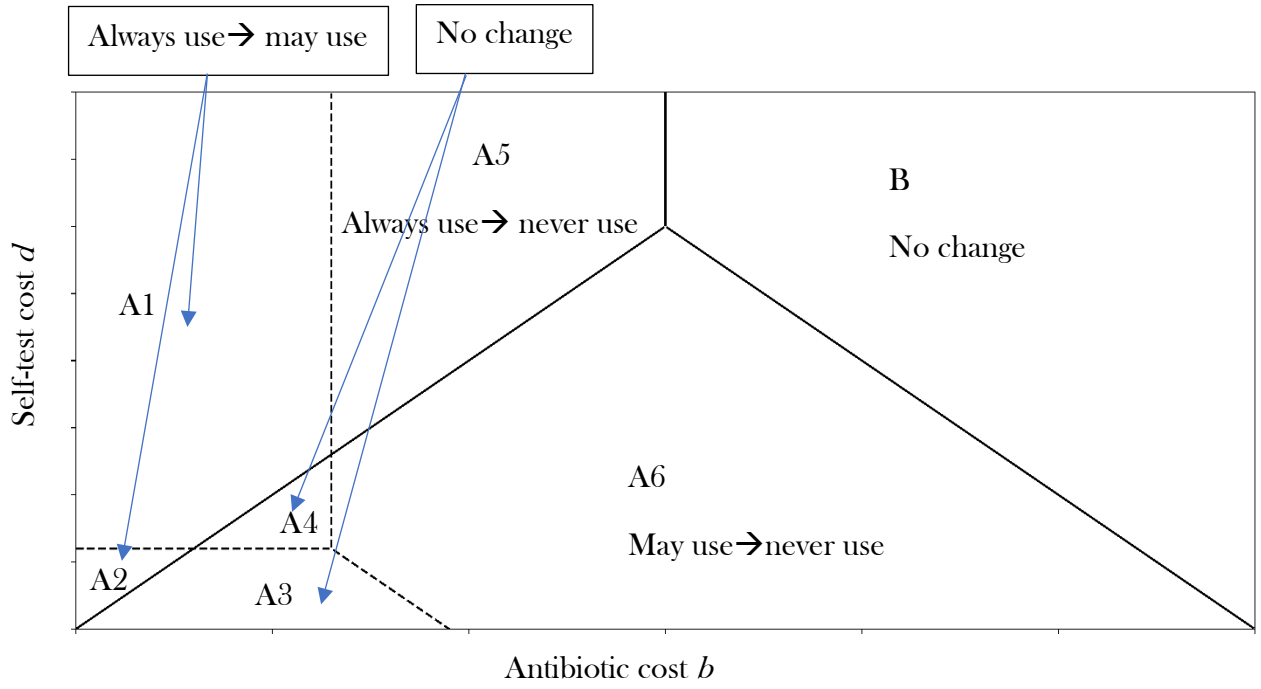

Figure C-24 Comparison between farmer's optimal strategies without and with PR in the *b*-*d* plane when veterinary service cost satisfies $l_3 - l_2 < v < l_3 - \beta l_1 - (1-\beta) l_2$.

	Without PR	**Under PR**
A1	Neither, always treat	Call, treat if *E*, do not treat if *I*
A2	Neither, always treat	Self-test, call and treat if *E*, neither call nor treat if *I*
A3	Self-tests, never call, treat if *E*, do not treat if *I*	Self-test, call and treat if *E*, neither call nor treat if *I*
A4	Self-tests, never call, treat if *E*, do not treat if *I*	Call, treat if *E*, do not treat if *I*
A5	Neither, always treat	Neither, never treat
A6	Self-tests, never call, treat if *E*, do not treat if *I*	Neither, never treat
B	Neither, never treat	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

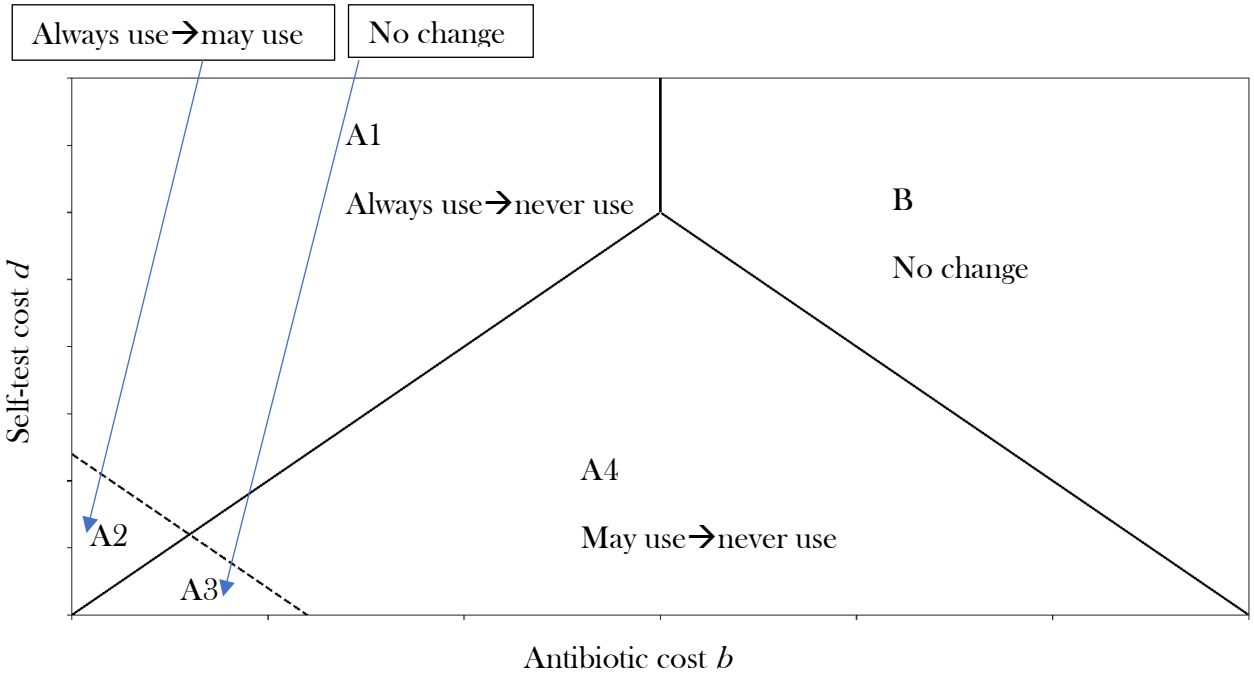

Figure C-25 Comparison between farmer's optimal strategies without and with PR in the *b*-*d* plane when veterinary service cost satisfies $l_3 - \beta l_1 - (1-\beta) l_2 < v < l_3 - l_1$.

	Without PR	**Under PR**
A1	Neither, always treat	Neither, never treat
A2	Neither, always treat	Self-test, call and treat if *E*, neither call nor treat if *I*
A3	Self-tests, never call, treat if *E*, do not treat if *I*	Self-test, call and treat if *E*, neither call nor treat if *I*
A4	Self-tests, never call, treat if *E*, do not treat if *I*	Neither, never treat
B	Neither, never treat	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

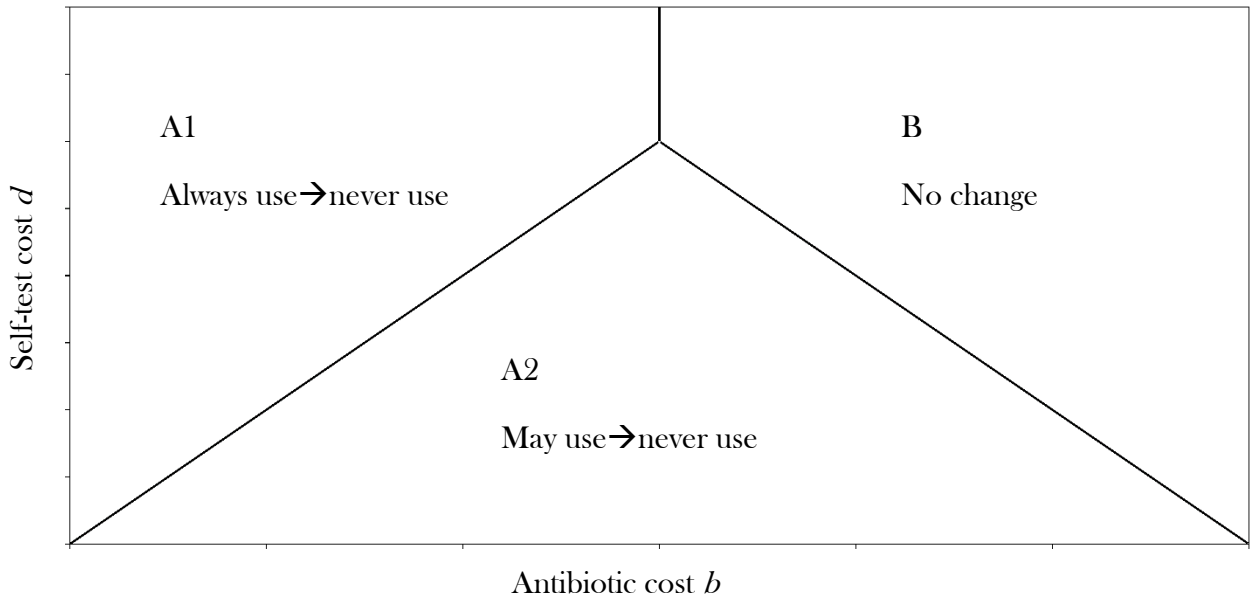

Figure C-26 Comparison between farmer's optimal strategies without and with PR in the *b*-*d* plane when veterinary service cost satisfies $v > l_3 - l_1$.

	Without PR	Under PR
A1	Neither, always treat	Neither, never treat
A2	Self-tests, never call, treat if *E*, do not treat if *I*	Neither, never treat
B	Neither, never treat	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

C9 Compare farmer's optimal strategies without and with PR in the *b*-*v* plane

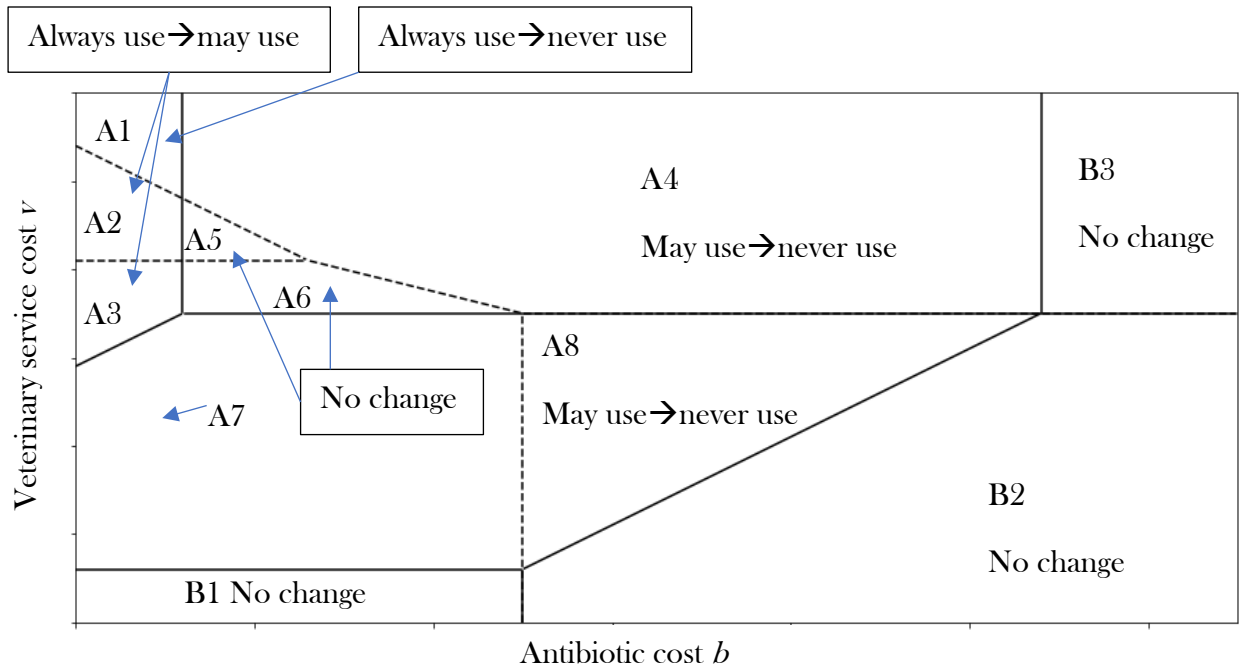

Figure C-27 Comparison between farmer's optimal strategies without and with PR in the *b*-*v* plane when self-test cost satisfies $d < \beta(1-\beta)(l_2 - l_1)$.

	Without PR	**Under PR**
A1	Neither, always treat	Neither, never treat
A2	Neither, always treat	Self-test, call and treat if *E*, neither call nor treat if *I*
A3	Neither, always treat	Call, treat if *E*, do not treat if *I*
A4	Self-tests, never call, treat if *E*, do not treat if *I*	Neither, never treat
A5	Self-tests, never call, treat if *E*, do not treat if *I*	Self-test, call and treat if *E*, neither call nor treat if *I*
A6	Self-tests, never call, treat if *E*, do not treat if *I*	Call, treat if *E*, do not treat if *I*
A7	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, treat if *E*, do not treat if *I*
A8	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, never treat
B1	Call, treat if *E*, do not treat if *I*	Same
B2	Call, never treat	Same
B3	Neither, never treat	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

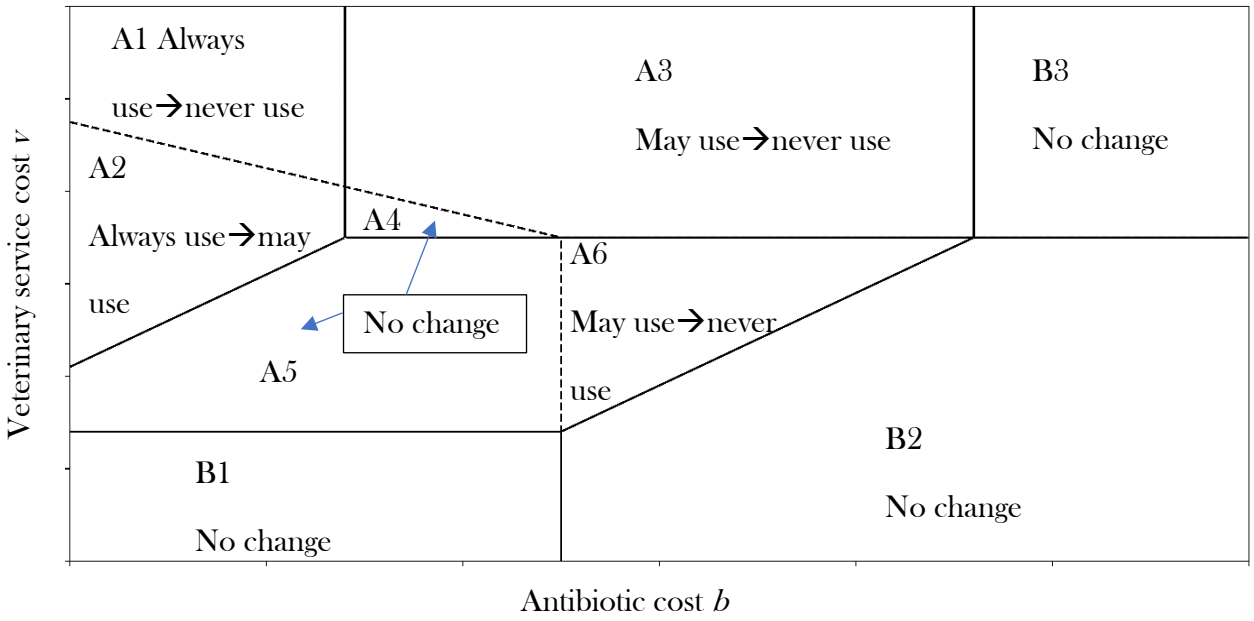

Figure C-28 Comparison between farmer's optimal strategies without and with PR in the *b*-*v* plane when self-test cost satisfies $\beta(1-\beta)(l_2-l_1) < d < \beta(1-\beta)(l_3-l_1)$.

	Without PR	**Under PR**
A1	Neither, always treat	Neither, never treat
A2	Neither, always treat	Call, treat if *E*, do not treat if *I*
A3	Self-tests, never call, treat if *E*, do not treat if *I*	Neither, never treat
A4	Self-tests, never call, treat if *E*, do not treat if *I*	Call, treat if *E*, do not treat if *I*
A5	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, treat if *E*, do not treat if *I*
A6	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, never treat
B1	Call, treat if *E*, do not treat if *I*	Same
B2	Call, never treat	Same
B3	Neither, never treat	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

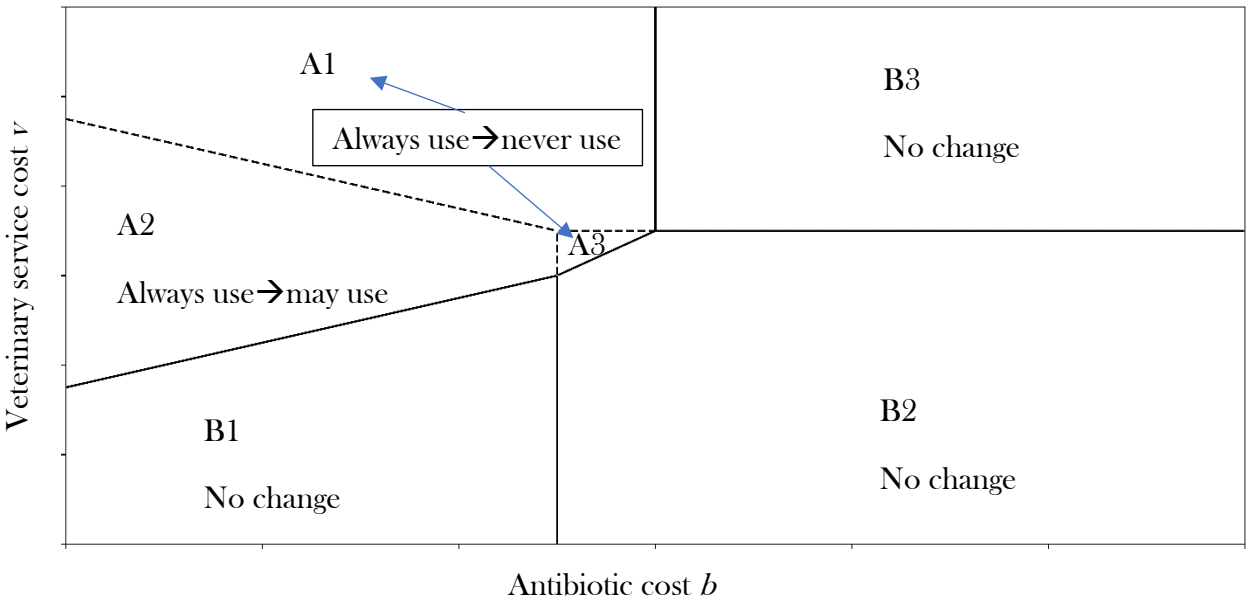

Figure C-29 Comparison between farmer's optimal strategies without and with PR in the b-v plane when self-test cost satisfies $d > \beta(1-\beta)(l_3 - l_1)$.

	Without PR	**Under PR**
A1	Neither, always treat	Neither, never treat
A2	Neither, always treat	Call, treat if *E*, do not treat if *I*
A3	Neither, always treat	Call, never treat
B1	Call, treat if *E*, do not treat if *I*	Same
B2	Call, never treat	Same
B3	Neither, never treat	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

C10 Compare farmer's optimal strategies without and with PR in the d-v plane

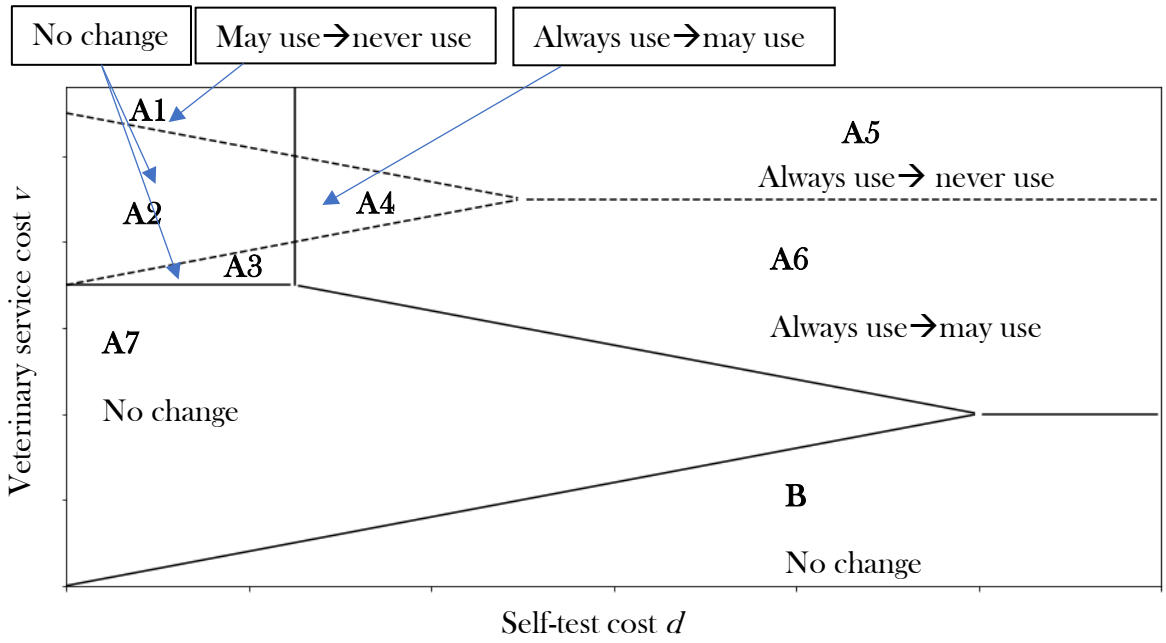

Figure C-30 Comparison between farmer's optimal strategies without and with PR in the d-v plane when low antibiotic cost $b < l_2 - l_1$

	Without PR	**Under PR**
A1	Self-tests, never call, treat if *E*, do not treat if *I*	Neither, never treat
A2	Self-tests, never call, treat if *E*, do not treat if *I*	Self-test, call and treat if *E*, neither call nor treat if *I*
A3	Self-tests, never call, treat if *E*, do not treat if *I*	Call, treat if *E*, do not treat if *I*
A4	Neither, always treat	Self-test, call and treat if *E*, neither call nor treat if *I*
A5	Neither, always treat	Neither, never treat
A6	Neither, always treat	Call, treat if *E*, do not treat if *I*
A7	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, treat if *E*, do not treat if *I*
B	Call, treat if *E*, do not treat if *I*	Same

Notes: Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

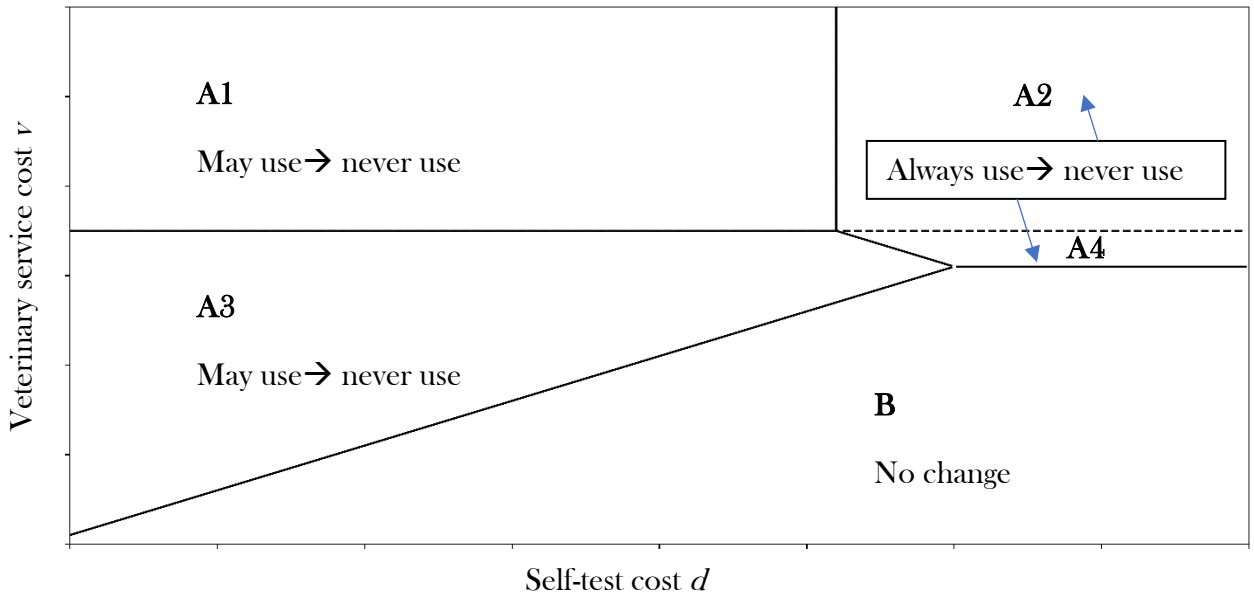

Figure C-31 Comparison between farmer's optimal strategies with and without PR in the d-v plane when antibiotic cost satisfies $l_2 - l_1 < b < l_3 - l_1$.

	Without PR	Under PR
A1	Self-tests, never call, treat if *E*, do not treat if *I*	Neither, never treat
A2	Neither, always treat	Neither, never treat
A3	Self-tests, do not call but treat if *E*, call but do not treat if *I*	Call, never treat
A4	Neither, always treat	Call, never treat
B	Call, never treat	Same

Notes: (1) Solid lines and dashed lines indicate optimal strategies for farmers without and with constraints respectively.

(2) When $b > l_3 - l_1$, the farmer's optimal strategies without and with PR are the same. Therefore, the comparison figure is not included.

C11 Comparing farmer's optimal strategies under PR with social optimal decisions

We put both the farmer's optimal strategies under PR and socially optimal strategies in the same modified Figure C-30 (in the d-v plane) so as to better illustrate how PR performs from the perspective of social welfare. We assume low, medium and high antibiotic resistance cost and add dotted lines in Figure C-32, Figure C-33 and Figure C-34, respectively, to indicate the social optimum varying with cost parameters. We also provide an example comparison in the b-d plane. Based on Figure C-24, we assume low and high antibiotic resistance cost and add dotted lines in Figure C-35 and Figure C-36.

We use colors to illustrate an assessment of PR efficiency. In the white area, PR reduces social welfare: the unregulated farmer's choices realize social optimum while PR changes the wedge between actual choices and socially optimal choices. In dark grey areas, PR may change sub-optimal private choices and either improve or worsen welfare but does not produce social optimum. Neither farmer's choices without PR nor choices under PR attain social optimum. In light grey areas, PR improves the farmer's choices and produces social optimum. In pink area, the farmer's choices without and with PR both realize social optimum.

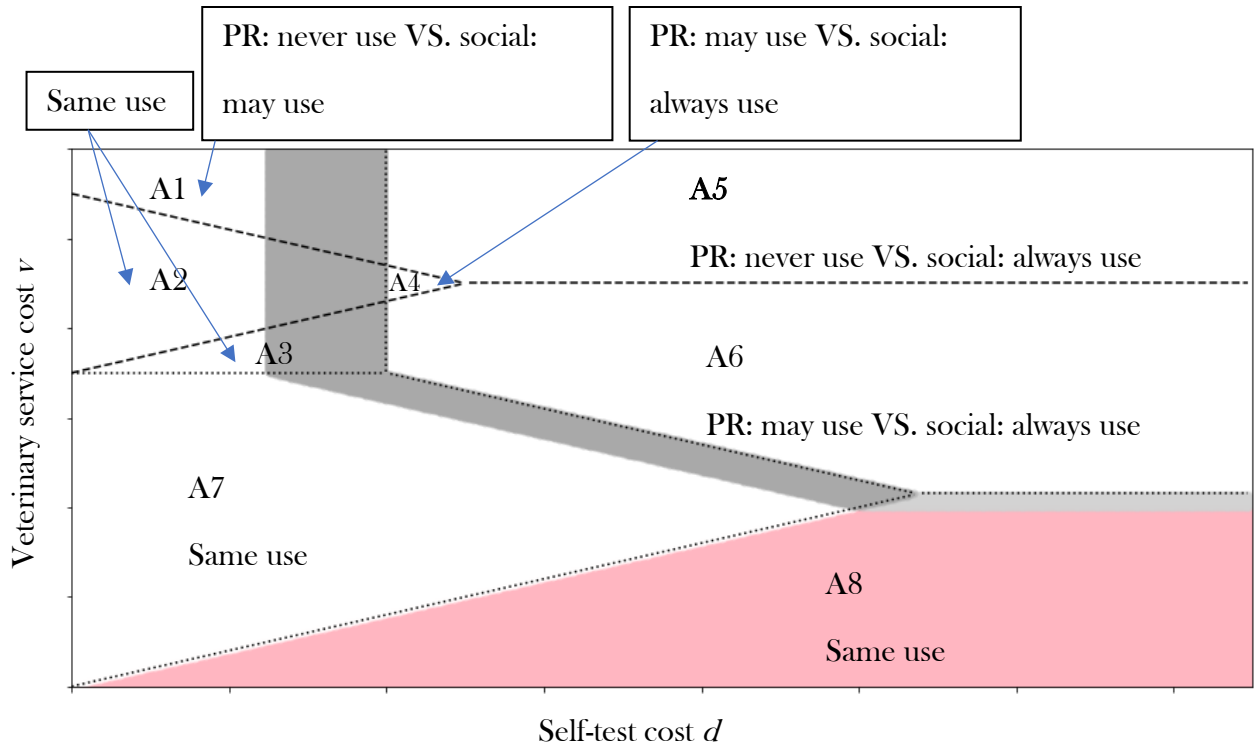

Figure C-32 Comparison between farmer's optimal strategies under PR and social optimum assuming low antibiotic cost $b < l_2 - l_1$ and low antibiotic resistance cost.

	Under PR	**Social optimum**
A1	Neither, never treat	Self-tests, never call, treat if *E*, do not treat if *I*
A2	Self-test; call and treat if *E*, neither call nor treat if *I*	Self-tests, never call, treat if *E*, do not treat if *I*
A3	Call, treat if *E*, do not treat if *I*	Self-tests, never call, treat if *E*, do not treat if *I*
A4	Self-test, call and treat if *E*, neither call nor treat if *I*	Neither, always treat
A5	Neither, never treat	Neither, always treat
A6	Call, treat if *E*, do not treat if *I*	Neither, always treat
A7	Call, treat if *E*, do not treat if *I*	Self-tests, do not call but treat if *E*, call but do not treat if *I*
A8	Call, treat if *E*, do not treat if *I*	**Same**

Notes: (1) Dashed lines indicate optimal strategies for farmers under PR. Dotted lines indicate social optimum.
(2) In the white area, the unregulated farmer's choices realize social optimum while PR changes the wedge between actual choices and socially optimal choices. In dark grey areas, neither farmer's choices without PR nor choices under PR attain social optimum. In light grey areas, PR improves the farmer's choices and produces social optimum. In pink area, the farmer's choices without and with PR both realize social optimum.

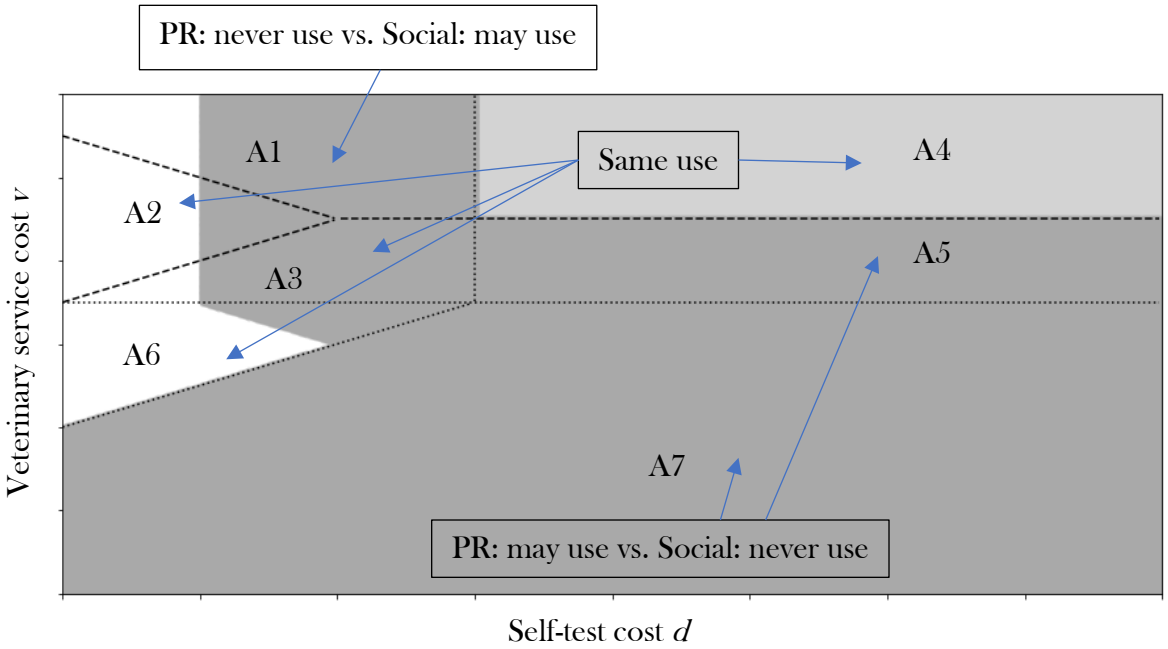

Figure C-33 Comparison between farmer's optimal strategies under PR and social optimum assuming low antibiotic cost $b < l_2 - l_1$ and medium antibiotic resistance cost

	Under PR	**Social optimum**
A1	Neither, never treat	Self-tests, never call, treat if *E*, do not treat if *I*
A2	Self-test; call and treat if *E*, neither call nor treat if *I*	Self-tests, never call, treat if *E*, do not treat if *I*
A3	Call, treat if *E*, do not treat if *I*	Self-tests, never call, treat if *E*, do not treat if *I*
A4	Neither, never treat	**Same**
A5	Call, treat if *E*, do not treat if I	Neither, never treat
A6	Call, treat if *E*, do not treat if *I*	Self-tests, do not call but treat if *E*, call but not treat if *I*
A7	Call, treat if *E*, do not treat if *I*	Call, never treat

Notes: (1) Dashed lines indicate optimal strategies for farmers under PR. Dotted lines indicate social optimum.
2) In the white area, the unregulated farmer's choices realize social optimum while PR changes the wedge between actual choices and socially optimal choices. In dark grey areas, neither farmer's choices without PR nor choices under PR attain social optimum. In light grey areas, PR improves the farmer's choices and produces social optimum.

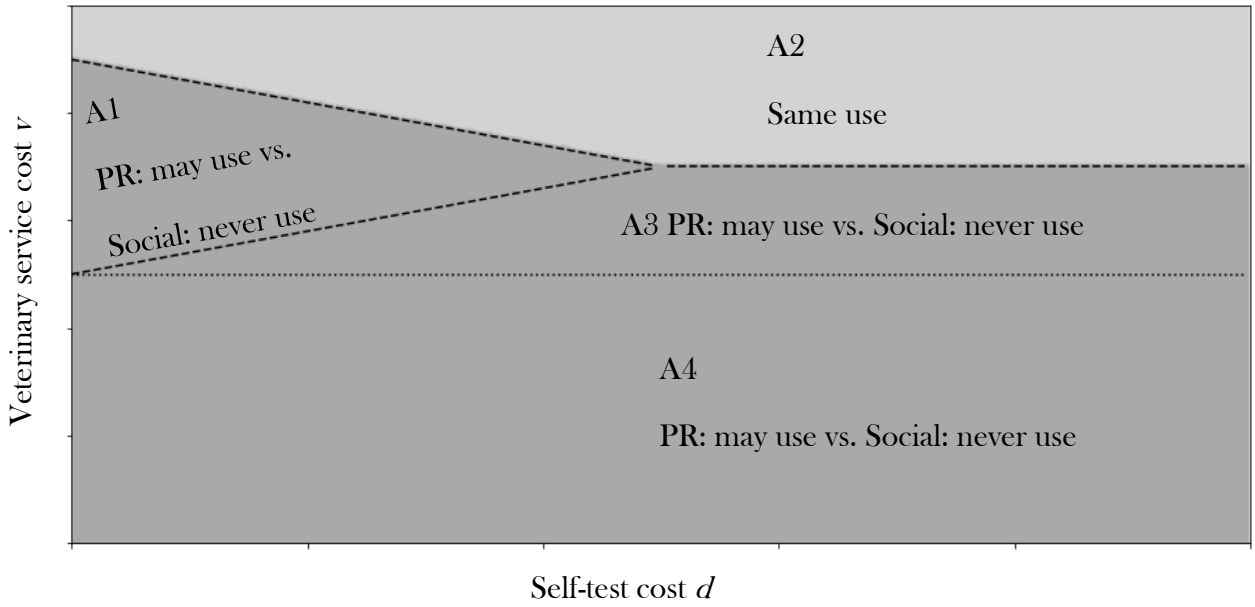

Figure C-34 Comparison between farmer's optimal strategies under PR and social optimum assuming low antibiotic cost $b < l_2 - l_1$ and high antibiotic resistance cost.

	Under PR	**Social optimum**
A1	Self-test; call and treat if *E*, neither call nor treat if *I*	Neither, never treat
A2	Neither, never treat	**Same**
A3	Call, treat if *E*, do not treat if *I*	Neither, never treat
A4	Call, treat if *E*, do not treat if *I*	Call, never treat

Notes: (1) Dashed lines indicate optimal strategies for farmers under PR. Dotted lines indicate social optimum.
(2) In dark grey areas, neither farmer's choices without PR nor choices under PR attain social optimum. In light grey areas, PR improves the farmer's choices and produces social optimum.

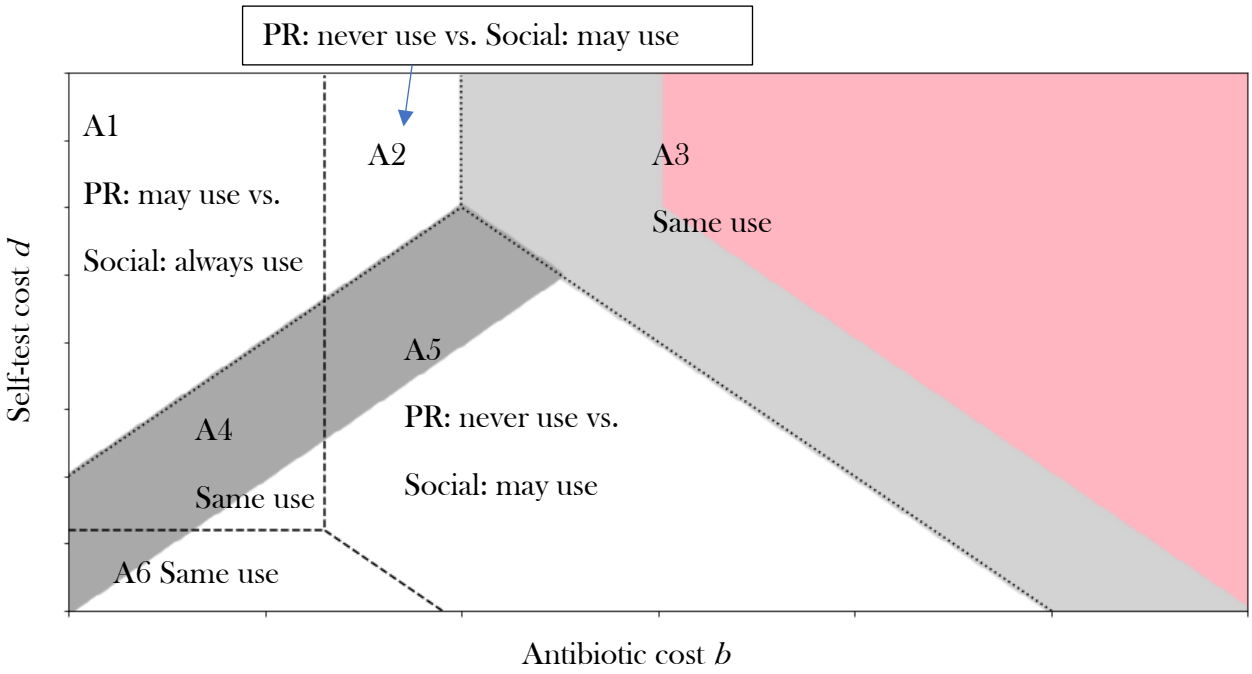

Figure C-35 Comparison between farmer's optimal strategies under PR and social optimum assuming high veterinary service cost $v > l_3 - l_2$ and low antibiotic resistance cost.

Area	Under PR	Social optimum
A1	Call, treat if *E*, do not treat if *I*	Neither call nor self-test, always treat
A2	Neither call nor self-test, never treat	Neither call nor self-test, always treat
A3	Neither call nor self-test, never treat	Same
A4	Call, treat if *E*, do not treat if *I*	Self-test, never call, treat if *E*, do not treat if *I*
A5	Neither call nor self-test, never treat	Self-test, never call, treat if *E*, do not treat if *I*
A6	Self-test, call and treat if *E*, neither call nor treat if *I*	Self-test, never call, treat if *E*, do not treat if *I*

Notes: (1) Dashed lines indicate optimal strategies for farmers under PR. Dotted lines indicate social optimum.
2) In the white area, the unregulated farmer's choices realize social optimum while PR changes the wedge between actual choices and socially optimal choices. In dark grey areas, neither farmer's choices without PR nor choices under PR attain social optimum. In light grey areas, PR improves the farmer's choices and produces social optimum. In pink area, the farmer's choices without and with PR both realize social optimum.

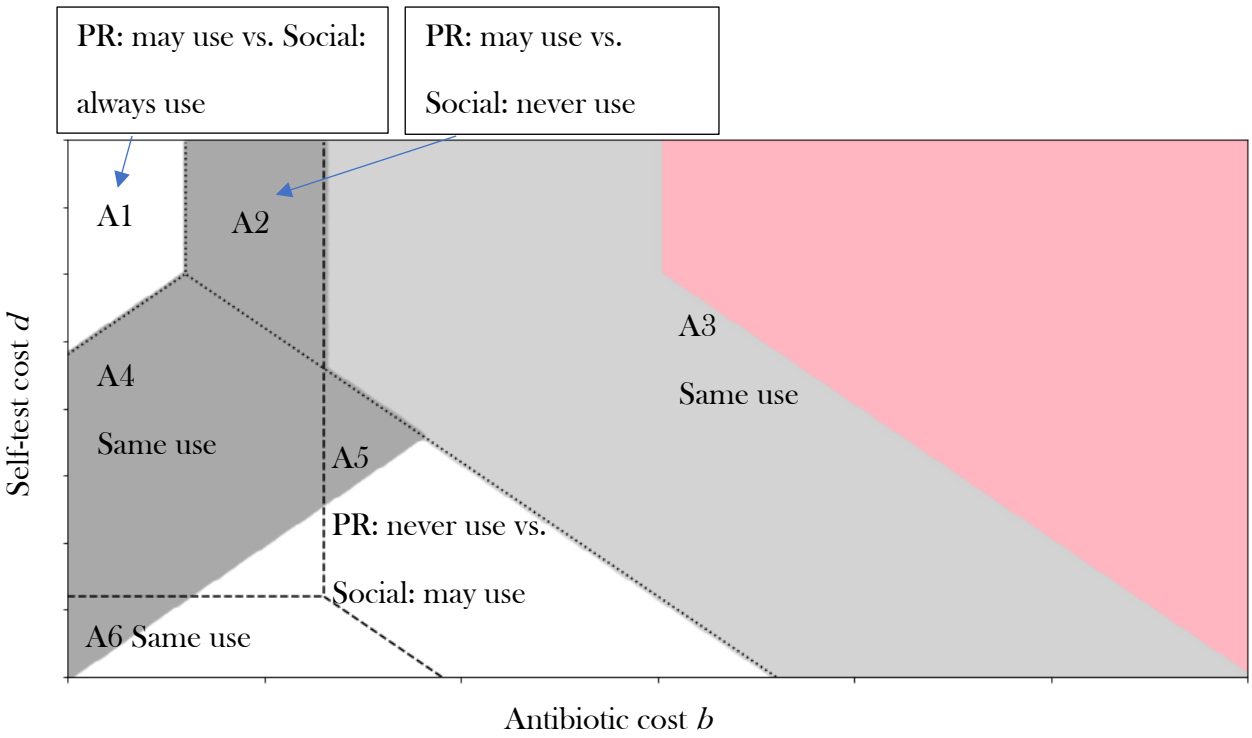

Figure C-36 Comparison between farmer's optimal strategies under PR and social optimum assuming high veterinary service cost $v > l_3 - l_2$ and high antibiotic resistance cost.

Area	Under PR	Social optimum
A1	Call, treat if *E*, do not treat if *I*	Neither call nor self-test, always treat
A2	Call, treat if *E*, do not treat if I	Neither call nor self-test, never treat
A3	Neither call nor self-test, never treat	Same
A4	Call, treat if *E*, do not treat if *I*	Self-test, never call, treat if *E*, do not treat if *I*
A5	Neither call nor self-test, never treat	Self-test, never call, treat if *E*, do not treat if *I*
A6	Self-test, call and treat if *E*, neither call nor treat if *I*	Self-test, never call, treat if *E*, do not treat if *I*

Notes: (1) Dashed lines indicate optimal strategies for farmers under PR. Dotted lines indicate social optimum.
2) In the white area, the unregulated farmer's choices realize social optimum while PR changes the wedge between actual choices and socially optimal choices. In dark grey areas, neither farmer's choices without PR nor choices under PR attain social optimum. In light grey areas, PR improves the farmer's choices and produces social optimum. In pink area, the farmer's choices without and with PR both realize social optimum.